Complete Summary

GUIDELINE TITLE

Removal of the endotracheal tube—2007 revision & update.

BIBLIOGRAPHIC SOURCE(S)

American Association for Respiratory Care (AARC). Removal of the endotracheal tube--2007 revision & update. Respir Care 2007 Jan;52(1):81-93. [189 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: American Association for Respiratory Care (AARC). Removal of the endotracheal tube. Respir Care 1999 Jan;44(1):85-90.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Pulmonary disease or other condition where use of endotracheal tube is necessary

GUIDELINE CATEGORY

Evaluation
Management
Risk Assessment

CLINICAL SPECIALTY

Critical Care
Emergency Medicine
Internal Medicine
Pediatrics
Pulmonary Medicine

INTENDED USERS

Respiratory Care Practitioners

GUIDELINE OBJECTIVE(S)

To focus on the predictors that aid the decision to extubate, the procedure referred to as extubation, and the immediate postextubation interventions that may avoid potential reintubation

Note: This review will not address weaning from mechanical ventilation, accidental extubation, nor terminal extubation.

TARGET POPULATION

Adult, pediatric and neonatal patients with endotracheal tubes

INTERVENTIONS AND PRACTICES CONSIDERED

Removal of the endotracheal tube (extubation) including

- Assessment of extubation readiness as determined by established readiness criteria
- Assessment of risk factors for extubation failure
- Prophylactic medication prior to extubation to avoid or reduce complications
- Assessment of outcome (physical examination, auscultation, postextubation respiratory support, postextubation medical therapy)
- Patient and equipment monitoring
- Standard precautions

MAJOR OUTCOMES CONSIDERED

- Clinical outcome as assessed by physical examination, auscultation, invasive and noninvasive measurements of arterial blood gas values, and chest radiography
- Extubation complications and the need for reintubation
- Sensitivity and specificity of tests

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

Not stated

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Not stated

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not applicable

METHODS USED TO ANALYZE THE EVIDENCE

Review

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Not stated

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

External Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

This guideline was approved by the 2006 Clinical Practice Guidelines Steering Committee.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Environment

The endotracheal tube should be removed in an environment in which the patient can be physiologically monitored and in which emergency equipment and appropriately trained health care providers with airway management skills are immediately available (see "Resources" and "Monitoring" sections below).

Indications/Objectives

When the airway control afforded by the endotracheal tube is deemed to be no longer necessary for the continued care of the patient, the tube should be removed. Subjective or objective determination of improvement of the underlying condition impairing pulmonary function and/or gas exchange capacity is made prior to extubation (MacIntyre et al., 2001). To maximize the likelihood for successful extubation, the patient should be capable of maintaining a patent airway and generating adequate spontaneous ventilation. In general, this requires the patient to possess adequate: central inspiratory drive, respiratory muscle strength, cough strength to clear secretions, laryngeal function, nutritional status, and clearance of sedative and neuromuscular blocking effects.

- Occasionally, acute airway obstruction of the artificial airway due to mucus or mechanical deformation mandates immediate removal of the artificial airway. Reintubation or other appropriate techniques for reestablishing the airway (i.e., surgical airway management) must be used to maintain effective gas exchange (Cohen et al., 1988; Skoulas & Kountakis, 2003; Kapadia et al., 2001).
- Patients in whom an explicit declaration of the futility of further medical care is documented may have the endotracheal tube removed despite failure to meet the above indications ("Consensus report," 1990; Truog et al., 2001).

Contraindications

There are no absolute contraindications to extubation; however, to maintain acceptable gas exchange after extubation some patients may require one or more of the following: noninvasive ventilation, continuous positive airway pressure, high inspired oxygen fraction, or reintubation. Airway protective reflexes may be depressed immediately following and for some time after extubation (Leder, Cohn, & Moller, 1998; Ajemian et al., 2001). Therefore, measures to prevent aspiration should be considered.

Hazards/Complications

Refer to the Potential Harms field for information on hazards and complications of extubation.

Limitations of Methodology/Validation of Results

Predicting extubation outcome is of significant clinical importance as both extubation delay and unsuccessful extubation are associated with poor patient outcomes (Epstein, 2002; MacIntyre et al., 2001). However, the literature on this topic is limited by few validated objective measures to accurately predict the extubation outcome for an individual patient (Epstein, 2002; MacIntyre et al., 2001; Epstein, 2000; Davis & Henderson-Smart, 2001; Sinha & Donn, 2002; Epstein, 2001). Failed extubation, or the need to reinsert an artificial airway following extubation, is not necessarily an indication of failed medical practice. Patients may need reintubation immediately or after some interval due to inappropriately timed extubation, progression of underlying disease, or development of a new disorder. Therefore, a trial of extubation may be used in some marginal patients with the expectation that the need for reintubation is likely. Clinical practice standards for endotracheal tube removal include attentive postextubation monitoring, prompt identification of respiratory distress, maintenance of a patent airway and, if clinically indicated, attempts to successfully establish an artificial airway by reintubation or surgical technique. The failure and complication rates of extubation can be used as quality monitors.

Assessment of Extubation Readiness

The endotracheal tube should be removed as soon as the patient no longer needs an artificial airway. Patients should demonstrate some evidence for the reversal of the underlying cause of respiratory failure and should be capable of maintaining adequate spontaneous ventilation and gas exchange. The determination of extubation readiness may be individualized using the following guidelines.

1. Patients with an artificial airway to facilitate treatment of respiratory failure should be considered for extubation when they have met established extubation readiness criteria (DeHaven, Hurst, & Btanson, 1986; Leitch, Moran, & Grealy, 1996). Examples of these criteria include but are not limited to
    - The capacity to maintain adequate arterial partial pressure of oxygen (arterial oxygen pressure/fraction of inspired oxygen [PaO_2/FIO_2] ratio > 150-200) on inspired oxygen fractions provided with simple oxygen devices ($FIO_2 \leq 0.4$ to 0.5 and with low levels of positive airway pressure [PEEP] ≤ 5 to 8 cm H_2O) (MacIntyre et al., 2001)
    - The capacity to maintain appropriate pH (pH ≥ 7.25) (MacIntyre et al., 2001) and arterial partial pressure of carbon dioxide during spontaneous ventilation (Berman et al., 1976; Kim & Boutwell, 1987)
    - Successful completion of 30–120 minute spontaneous breathing trial (SBT) performed with a low level of continuous positive airway pressure (CPAP) (e.g. 5 cm H_2O) or low level of pressure support (e.g. 5-7 cm H_2O) demonstrating adequate respiratory pattern and gas exchange, hemodynamic stability, and subjective comfort (Farias et al., 2001; Esteban et al., 1997; Esteban et al., 1999; Vallverdu et al., 1998; Ely et al., 1999)
    - In adults, respiratory rate < 35 breaths per minute during spontaneous breathing (Cohen et al., 1982); in infants and children, the acceptable respiratory rate decreases inversely with age and can be measured with good repeatability with a stethoscope (Rusconi et al., 1994)

- Adequate respiratory muscle strength (Bellemare & Grassino, 1982; Jubran & Tobin, 1997; Roussos & Macklem, 1982)
- Maximum negative inspiratory pressure > -30 cm H_2O (Sahn & Lakshminarayan, 1973; Hess, 1989; Marini, Smith, & Lamb, 1986; Belani et al., 1980) although current clinical practice may accept a maximum negative inspiratory pressure > -20 cmH_2O (Yang & Tobin, 1991; Martin, Bratton, & Walker, 1996)
- Vital capacity > than 10 mL/kg ideal body weight (Bendixen et al., 1965) or in neonates >150 mL/m^2 (Belani et al., 1980)
- Pressure measured across the diaphragm during spontaneous ventilation < 15% of maximum (Aubier et al., "Bilateral," 1985; Tobin, Laghi, & Jubran, 1998)
- In adults, spontaneous exhaled minute ventilation < 10 L/min (Sahn & Lakshminarayan, 1973)
- In adults, a rapid shallow breathing index (RSBI, respiratory rate-to-tidal-volume ratio) of $\leq$ 105 breaths/min (positive predictive value [PPV] of 0.78) (Yang & Tobin, 1991); in infants and children, variables standardized by age or weight proved more useful. Modified CROP index (compliance, resistance, oxygenation, and ventilating pressure) above the threshold of $\geq$ 0.1 to 0.15 mL x mm Hg/breaths/min/kg) (sensitivity of 83% and specificity of 53%) may be a superior screening tool than a modified RSBI $\leq$ 8–11 breaths/min/mL/kg (sensitivity of 74% and specificity of 74%) (Farias et al., 1998; Baumeister et al., 1997; Thiagarajan et al., 1999)
- Thoracic compliance > 25 mL/cm H_2O (Peters et al., 1972)
- Work of breathing < 0.8 J/L (Lee et al., 1994; Krieger et al., 1997; Lewis et al., 1988; Levy, Miyasaki, & Langston, 1995; Kirton et al., 1995; Shikora et al., 1990)
- Oxygen cost of breathing < 15% total especially for those patients with chronic respiratory insufficiency requiring long-term mechanical ventilation (sensitivity 100%; specificity 87%) (Shikora et al., 1990; Harpin et al., 1987; Shikora, Benotti, & Johannigman, 1994)
- Dead-space-to-tidal-volume ratio (V_D/V_T) < 0.6; in children, $V_D/V_T \leq$ 0.5 equates to 96% successful extubation, 0.51-0.64 equates to 60% successful extubation, 0.65 equates to 20% successful extubation (Tahvanainen, Salmenpera, & Nikki, 1983; Hubble et al., 2000)
- Airway occlusion pressure at 0.1 seconds ($P_{0.1}$) < 6 cm H_2O and when normalized for maximal inspiratory pressure (MIP), as indicated by [$P_{0.1}$/MIP], accurately predicts successful extubation 88% and 98% of the time, respectively (Capdevila et al., 1995; Montgomery et al., 1987; Gandia & Blanco, 1992). (This measurement is primarily a research tool.)
- Maximum voluntary ventilation > twice resting minute ventilation (Sahn & Lakshminarayan, 1973)
- In preterm infants, minute ventilation testing vs. standard clinical evaluation resulted in shorter time to extubation (Gillespie et al., 2003)
- Peak expiratory flow (PEF) ≥ 60 L/min after 3 cough attempts measured with an in-line spirometer (Smina et al., 2003; Bach & Saporito, 1996)
- Time to recovery of minute ventilation to pre-spontaneous breathing trial baseline levels (Martinez, Seymour, & Nam, 2003)

- Sustained maximal inspiratory pressures (SMIP) > 57.5 pressure time units (sensitivity and specificity of 1.0) predicted extubation outcome (Bruton, 2002)
- In neonates, total respiratory compliance (C_{rs}, derived from V_T/PIP-PEEP) ≤ 0.9 mL/cm H_2O was associated with extubation failure, whereas a value ≥ 1.3 mL/cm H_2O was associated with extubation success (Balsan et al., 1990)
- Preterm infants extubated directly from low rate ventilation without a trial of endotracheal tube continuous positive airway pressure (CPAP) demonstrated a trend to increased chance of successful extubation (Davis & Henderson-Smart, 2001)
- Integrated indices of measured vital capacity (VC, threshold value = 635 mL), respiratory frequency to tidal volume ratio (f/V_T, threshold value = 88 breaths/min/L) and maximal expiratory pressure (MEP, threshold value = 28 cm H_2O) (Vallverdu et al., 1998; Zeggwagh et al., 1999)

2. In addition to treatment of respiratory failure, artificial airways are sometimes placed for airway protection. Resolution of the need for airway protection may be assessed by but is not limited to
    1. Appropriate level of consciousness (Redmond et al., 1996; Harel et al., 1997; Coplin et al., 2000)
    2. Adequate airway protective reflexes (Harel et al., 1997; Coplin et al., 2000)
        - Reduced cough strength (grade 0 to 2) measured by the white card test and increased secretion burden predicted unsuccessful extubation (Khamiees et al., 2001)

    3. Easily managed secretions (Epstein, 2002; Epstein, 2001; Harel et al., 1997; Coplin et al., 2000)

3. In addition to resolution of the processes requiring the insertion of an artificial airway, issues that should be considered in all patients prior to extubation are
    1. No immediate need for reintubation anticipated
    2. Known risk factors for extubation failure
        - Patient features of high risk for extubation failure include: admission to medical intensive care unit (ICU), age > 70 or < 24 months, higher severity of illness upon weaning, hemoglobin (Hgb) <10 mg/dL, use of continuous I.V. sedation, longer duration of mechanical ventilation, presence of a syndromic or chronic medical condition, known medical or surgical airway condition (Epstein, 2001; Kurachek et al., 2003), frequent pulmonary toilet (Khamiees et al., 2001), and loss of airway protective reflexes (Harel et al., 1997; Coplin et al., 2000)
        - Risk factors for a known history of a difficult airway: syndromic or congenital conditions associated with cervical instability (i.e., Klippel-Feil or Trisomy 21); limited physical access to the airway (i.e., halo-vest or anatomic hindrances); multiple failed direct laryngoscopy attempts by an experienced laryngoscopist, or a failed laryngoscopy attempt followed by tracheal intubation using fiberoptic bronchoscopy or nasal lightwand, or requiring placement of a laryngeal mask airway (Deem & Bishop, 1995;

American Society of Anesthesiologists [ASA] Task Force on Management of the Difficult Airway, 2003; Cork & Monk, 1992; Van Boven et al., 1996; Mort, 2003; Loudermilk et al., 1997; Hartmannsgruber, Loudermilk, & Stoltzfus, 1997; Hartmannsgruber & Rosenbaum, 1998)
    - In the pediatric cardiothoracic surgery population, presence of one or more of these variables increases the likelihood of failed extubation: age < 6 months, history of prematurity, congestive heart failure, and pulmonary hypertension (Davis et al., 2004)
    - For pediatric patients, validated bedside measures of respiratory function identifying low (< 10%) and high risk (> 25%) threshold values of extubation failure which may be useful in generating discussion, but do not apply to individual risk (Venkataraman, Khan, & Brown, 2000)

3. Presence of upper airway obstruction or laryngeal edema as detected by diminished gas leak around the endotracheal tube with positive pressure breaths (Mhanna et al., 2002; Fisher & Raper, 1992; Potgieter & Hammond, 1988; De Bast et al., 2002; Miller & Cole, 1996; Jaber et al., 2003; Marik, 1996; Sandhu et al., 2000; Engoren, 1999)
    - Percent cuff leak or the difference between expiratory tidal volume measured with the cuff inflated and then deflated in a volume-controlled mode of ≥15.5% (sensitivity 75%, specificity 72%) (Fisher & Raper, 1992; Potgieter & Hammond, 1988; De Bast et al., 2002; Miller & Cole, 1996; Jaber et al., 2003; Marik, 1996; Sandhu et al., 2000). Yet this test was found not to be predictive in a study of cardiothoracic surgery patients (Engoren, 1999).
    - Air leak may be an age-dependent predictor of postextubation stridor in children. An air leak > 20 cm H_2O was predictive of postextubation stridor in children ≥ 7 years of age (sensitivity of 83%, specificity of 80%), but was not predictive < 7 years of age (Mhanna et al., 2002)
    - Air leak test has been predictive of postextubation stridor or extubation failure for children with upper airway pathology: trauma patients (Kemper et al., 1991), croup (Adderly & Mullins, 1987), after tracheal surgery (Seid et al., 1991).

4. Evidence of stable, adequate hemodynamic function (MacIntyre et al., 2001; Morganroth et al.,1984; Clochesy, Daly, & Montenegro, 1995; Biery et al., 1990; Hammond et al., 1990)
5. Evidence of stable nonrespiratory functions (Rothaar & Epstein, 2003; Sapijaszko et al., 1996; Smith & Shneerson, 1995; Scheinhorn et al., 1995)
6. Electrolyte values within normal range (Cerra, 1987; Aubier et al., "Effect of hypophosphatemia," 1985; Aubier et al., "Effects of hypocalcemia," 1985)
7. Evidence of malnutrition decreasing respiratory muscle function and ventilatory drive (Pingleton & Harmon, 1987; Lewis et al., 1986; Doekel et al., 1976; Larca & Greenbaum, 1982; Bassili & Deitel, 1981)

8. Anesthesia literature indicates the patient must have no intake of food or liquid by mouth for a period of time prior to airway manipulation. The continuation of transpyloric feedings during an extubation procedure remains controversial (Lyons et al., 2002; ; American Academy of Pediatrics [AAP], 1992)
9. Prophylactic medication prior to extubation to avoid or reduce the severity of postextubation complications such as
    - Consider use of lidocaine to prevent cough and/or laryngospasm in patients at risk (Gefke, Andersen, & Friesel, 1983; Staffel et al., 1991)
    - Prophylactic administration of steroids may be helpful to prevent reintubation rates in high-risk neonates, but not in children (Davis & Henderson-Smart, 2001; Markovitz & Randolph 2000)
    - Prophylactic administration of steroids may help reduce the incidence of postextubation stridor in children, but not in neonates or adults (Davis & Henderson-Smart, 2001; Markovitz & Randolph 2000)
    - Prophylactic administration of steroids for patients with laryngotracheobronchitis (croup) correlates with reduced rates of reintubation (Freezer, Butt, & Phelan, 1990; Tibballs, Shann, & Landau, 1992)
    - Caffeine citrate reduced the risk of apnea for infants, but did not reduce the risk of extubation failure (Steer & Henderson-Smart, 2000)
    - Methylxanthine treatment stimulates breathing and reduces the rate of apnea for neonates with poor respiratory drive, especially extremely low birth-weight infants (Henderson-Smart & Davis, 2003)

Assessment of Outcome

Removal of the endotracheal tube should be followed by adequate spontaneous ventilation through the natural airway, adequate oxygenation, and no need for reintubation.

- Clinical outcome may be assessed by physical examination, auscultation, invasive and noninvasive measurements of gas exchange, and chest radiography.
- Quality of the procedure can be systematically assessed by monitoring extubation complications and the need for reintubation.
- The success of removal of the endotracheal tube can be monitored by examining the frequency of reintubation and frequency of complications.
- When a patient experiences an unplanned self-extubation and does not require reintubation, this suggests that planned extubation should have been considered earlier (Listello & Sessler, 1994; Epstein, 1995; Whelan, Simpson, & Levy, 1994; Tindol, DiBenedetto, & Kosciuk, 1994; Vassal et al., 1993; Franck, Vaughan, & Wallace, 1992).
- Some patients may require postextubation support or intervention to maintain adequate gas exchange independent of controlled mechanical ventilation.
    1. Noninvasive Respiratory Support

- Infants extubated to nasal intermittent positive pressure ventilation (NIPPV) were less likely to fail extubation than those infants extubated to nasal continuous positive airway pressure ventilation (NCPAP) (Davis, Lemyre, & de Paoli, 2001)
- In neonates and premature infants, binasal prong continuous positive airway pressure (CPAP) is more effective at preventing re-intubation than single nasal or nasopharyngeal prongs (De Paoli et al., 2002)
- In adults, routine use of postextubation noninvasive positive pressure ventilation such as BIPAP is not supported (Jiang, Kao, & Wang, 1999; Meyer & Hill, 1994; Keenan et al., 2002)
- In patients with chronic obstructive pulmonary disease (COPD), CPAP of 5 cm H_2O and pressure support ventilation (PSV) of 15 cm H_2O have improved pulmonary gas exchange, decreased intrapulmonary shunt fraction, and reduced patient work of breathing (Kilger et al., 1999)

2. Postextubation Medical Therapy
    - Aerosolized levo-epinephrine is as effective as aerosolized racemic epinephrine in the treatment of postextubation laryngeal edema in children (Nutman et al., 1994)
    - No randomized studies in neonates have been performed to evaluate the role of nebulized racemic epinephrine for postextubation stridor (Davies & Davis, 2002)
    - Heliox may alleviate the symptoms of partial airway obstruction and resultant stridor, improve patient comfort, decrease work of breathing, and prevent reintubation (Kemper et al., 1990; Kemper et al., 1991)

3. Diagnostic Therapy
    - For patients with postextubation complications such as stridor or obstruction, fiberoptic bronchoscopy may provide direct airway inspection and therapeutic interventions (secretion clearance, instillation of drugs, removal of aspirated foreign objects) (Liebler & Markin, 2000; Walker & Forte, 1993).

Resources

Preparation for extubation includes assuring emergency reintubation equipment and personnel are readily available. The following equipment/supplies must be maintained in close proximity to the patient, in sufficient quantities, and in working condition.

- Equipment:
    1. Oxygen source
    2. Devices to deliver oxygen-enriched gas mixtures
    3. High-volume suction source and catheters
    4. Pharyngeal and tracheal suction catheters
    5. Self-inflating or non-self-inflating manual ventilation system
    6. Appropriately sized face masks
    7. Oral and nasopharyngeal airways
    8. Endotracheal tubes of various sizes, cuffed and uncuffed

9. Translaryngeal intubation equipment (laryngoscope blades, handles, extra batteries, stylettes, surgical lubricant, syringes to inflate cuff)
10. Airway exchange catheter of various sizes
11. Laryngeal mask airway (LMA) of various sizes
12. Equipment for establishing an emergency surgical airway (scalpel, lidocaine with epinephrine, appropriately sized endotracheal or tracheostomy tubes)
13. Nasogastric tubes of various sizes
14. Pulse oximeter
15. Two-channel cardiac monitor
16. Supplies for arterial puncture and blood gas analysis
17. Medication for sedation, analgesia, neuromuscular blockade and prevention of raised intracranial pressure as indicated by the individual situation
18. Carbon dioxide detection devices (qualitative and/or quantitative devices)

- Personnel
    1. Credentialed and/or licensed health care personnel with documented knowledge and demonstrated skills specific to patient assessment and airway management should determine the appropriateness of extubation, be available to assess success, and begin appropriate interventions should immediate complications occur. Personnel skilled in endotracheal intubation and the insertion of invasive airways should be immediately available whenever extubation is performed.
    2. Credentialed and/or licensed health care personnel with documented knowledge and demonstrated skill in providing oxygen administration devices and suctioning the airway may provide support during the extubation procedure.
    3. In the event of acute obstruction of the artificial airway, anyone with airway maintenance skills may remove the endotracheal tube to save the patient's life (AAP, 1992).

Monitoring

Monitoring in the postextubation period includes ensuring the equipment, personnel, and medications are readily available in the event of emergent, postextubation phenomena (AAP, 1992).

- Appropriately trained personnel need to be readily available to detect cardiopulmonary impairment
- Frequent respiratory evaluation should include: vital signs, assessment of neurologic status, patency of airway, auscultatory findings, work of breathing, and hemodynamic status
- Equipment
    1. Pulse oximeter
    2. Two-channel cardiac monitor
    3. Sphygmomanometer and stethoscope
    4. Capnograph

Frequency

No consensus exists on the appropriate timing of or requirement for tracheostomy placement in the mechanically ventilated patient. Any recommendation will have to consider patient population, etiology of respiratory insult, expected or known duration of mechanical ventilation, balance of risks and perceived benefits of continued mechanical ventilation via tracheostomy as opposed to a translaryngeally-placed endotracheal tube. Past recommendations have been based upon expert consensus (MacIntyre et al., 2001; Plummer & Gracey, 1989; Maziak, Meade, & Todd, 1998)

- Limited data exist on the rate of successful extubation after a previous failed extubation.
    1. Many clinical studies include the first extubation attempt only
    2. In a pediatric descriptive study, 174/2794 subjects failed extubation (extubation failure rate 6.2%) after the first attempt; 27% (65/174) failed a second extubation attempt; of those patients, 22 extubated successfully after the third extubation attempt (Kurachek et al., 2003).

Standard Precautions

Caregivers should exercise Standard Precautions for all patients, follow Centers for Disease Control and Prevention (CDC) recommendations for control of exposure to tuberculosis and droplet nuclei, and institute appropriate precautions empirically for airborne, droplet, and contact agents pending confirmation of diagnosis in patients suspected of having serious infections (Garner, 1996; "Guidelines for preventing the transmission," 1994; Lange, 2003; Ho, Tang, & Seto, 2003; Tablan et al., 2004; Bolyard et al., 1998).

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

REFERENCES SUPPORTING THE RECOMMENDATIONS

References open in a new window

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of supporting evidence is not specifically stated for each recommendation.

The guideline is developed from a thorough review of the literature, surveys of current practice, and the expertise of the members of the Working Group.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Appropriate decision to discontinue mechanical ventilation that involved weighing the risks of prolonged mechanical ventilation against the possibility of extubation failure

POTENTIAL HARMS

- Hypoxemia after extubation may result from but is not limited to:
    1. Failure to deliver adequate inspired oxygen fraction through the natural upper airway
    2. Acute upper airway obstruction secondary to laryngospasm
    3. Development of post-obstruction pulmonary edema
    4. Bronchospasm
    5. Development of atelectasis, or lung collapse
    6. Pulmonary aspiration
    7. Hypoventilation

- Hypercapnia after extubation may be caused by but is not limited to:
    1. Upper airway obstruction resulting from edema of the trachea, vocal cords, or larynx
    2. Respiratory muscle weakness
    3. Excessive work of breathing
    4. Bronchospasm

- Death may occur when medical futility is the reason for removing the endotracheal tube.

CONTRAINDICATIONS

CONTRAINDICATIONS

There are no absolute contraindications to extubation.

QUALIFYING STATEMENTS

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No consensus exists on the appropriate timing of or requirement for tracheostomy placement in the mechanically ventilated patient. Any recommendation will have to consider patient population, etiology of respiratory insult, expected or known duration of mechanical ventilation, balance of risks and perceived benefits of continued mechanical ventilation via tracheostomy as opposed to a translaryngeally-placed endotracheal tube.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better
Living with Illness

IOM DOMAIN

Effectiveness
Safety

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

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ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1999 Jan (revised 2007 Jan)

GUIDELINE DEVELOPER(S)

American Association for Respiratory Care - Professional Association

SOURCE(S) OF FUNDING

American Association for Respiratory Care (AARC)

GUIDELINE COMMITTEE

Not stated

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Revised by Angela T Wratney, MD and Ira M Cheifetz, MD, FAARC, Duke University Medical Center, Durham, North Carolina

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: American Association for Respiratory Care (AARC). Removal of the endotracheal tube. Respir Care 1999 Jan;44(1):85-90.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American Association for Respiratory Care (AARC) Web site.

Print copies: Available from the American Association for Respiratory Care (AARC), CPG Desk, 11030 Ables Ln, Dallas, TX 75229-4593; Web site: www.aarc.org.

AVAILABILITY OF COMPANION DOCUMENTS

None available

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on April 25, 1999. The information was verified by the guideline developer on April 25, 1999. This NGC summary was updated by ECRI Institute on June 14, 2007.

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